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The Relationship between Game Genres, Learning Techniques and Learning Styles in Educational Computer Games

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Abstract. Educational computer game has many similar characteristics like any other genres of games. However its particular aspect is designed to teach, and in which main objective involves in learning a topic. To develop an effective educational computer game, different game genres, learning activities and techniques, and learning styles are important issues for consideration. This paper presents an analysis by comparing and establishing relationships between the game genres and learning techniques based on the types of learning and potential game style of Prensky [1] and learning styles based on the study of Chong et al. [2].

1 Introduction

Educational computer games and various forms of edutainment have gained much attention in the discipline of learning and teaching. Educators [3], [4], [5] believe that most children learn best through play. Most studies also show that 'learnt through play' [6] has proven to be a successful learning experience. Therefore, it is desirable to use educational computer games for teaching, which carry the objectives of play and learn in the classrooms. There are reasons for using computer games as a learning tool to enhance the learning experience of students. These reasons include the incorporation of rules, goals, engagement, challenge, feedback, fun, interactive, outcome and immediate reward [1], [7], [8], [9]. Even though most genres of the computer games in some ways are educational, educational computer games are designed with explicit educational purpose. When educational computer games are adopted in supporting learning in the classroom, the pedagogical aspects such as learning style should be taken into account. As different people learn and process information differently, it is important to understand individual learning style which allows the prediction of the way learners react and feel in different situations. Selecting the appropriate game genres for learning is another important issue for consideration to develop effective educational computer game. Recently, most studies focus on several variables when selecting game genres. This includes age level, gender, racial diversity, number of players, and the role of teacher.

Unfortunately, previous studies on the learning styles of the learners have not provided sufficient guidelines to design effective educational computer games to meet the needs of individual learners. However, there are two important studies which are relevant to the focus of this paper: Prensky [1] and Chong et al. [2]. Prensky's study presented a theory based on computer games and learning, whereas Chong's study focuses on the impact of learning styles using digital games. However, there are still some gaps between their works. Therefore, this study aims to explore alternatives by focusing on the learning techniques and the learning activities to match possible game genres discussed in Prensky and Chong's experimental research on computer game types and the four learning styles. In addition to the literature review, this paper takes a further step to develop a conceptual model based on those two studies in order to make a contribution to the knowledge.

2 Why Use Game for Learning?

Majority of children today are growing up in a digital society. Being accustomed to digital technology, children have changed considerably their ways of thinking and processing information based on different mindsets from their parents. For most children, computer games have become a major part of their lives and become the most common activity in children's leisure time. To help in understanding the differences between today and previous generations, and to justify why computer games need to be a part of education, Prensky [1] proposes ten aspects of comparison that include: 1) twitch speed and conventional speed, 2) parallel processing and linear processing, 3) graphic first and text first, 4) random access and step-by-step, 5) connected and standalone, 6) active and passive, 7) play and work, 8) payoff and patience, 9) fantasy and reality, and, 10) technology-as-friend and technology-as-foe.

In the educational aspect, educators believe that children learn best when it is fun. It can be said that it is a natural way for children to learn through play. Through play, human can acquire skill without knowing it. Most studies [1], [3], [4], [5], [6] also show that "learn through play" is a natural and universal learning tool for children and adult. Therefore, it makes sense to see play as a valued contributor to a child's development and it should be given a place in the school curriculum. Computer game, a media that is based on playing and entertaining, can be treated as learning-oriented game which is also known as "edutainment" [5]. While edutainment bring the concept of entertainment and education at the same time, computer games also bring together the idea of game, play, fun, and hand-on experience in the learning environment. Consequently, playing computer game can be assumed that it is the activity of learn through play. Prensky [1] confirms two reasons why use computer games for learning: 1) today's learners have change radically, and 2) these learners need to be motivated in new ways. Furthermore, the main reasons people play games because the process of game playing is engagement and games bring combination of motivating elements [1].

Apart from these, there are several other reasons why computer games can be used as a learning tool. The reasons include: computer games have rules, goals, interaction, and content and story. Gee [4] mentioned that games are heavily motivating. They teach people to think about complex systems to solve problems in a complex world. Games make player think about decision they are making and how do the decision will

impact on this situations. Games deploy rich visual that draw players into fantasy worlds and motivate the player via fun, via challenge and via instant feedback. With instant feedback and immediate reward computer games provide, it makes a crucial aspect for learning.

3 Educational Computer Game

Basically, educational computer games have the same characteristics like any other types of computer games. The particular aspect of this type of game is designed to teach, and in which the main objective involves the learning of a lesson. Rather than being structured as a straightforward set of lessons or exercises, this type of educational software is structured like games, with such elements as scoring, timed performances, or incentives given for correct answers. Some examples of educational computer games include: Basic Math, eduProfix, Mario's Early Year, Fun with Numbers, Mario Teachers Typing, Math Blaster, Episode 1, Math Grand Prix, Morse, Number Games, Pelmanism, Playschool Math, Spelling Games, Urban Jungle, Word Games, Zoombinis.

Many educational games of the past have been skill-and-drill (the common example is MathBlasters) One could argue that there is a place for skill-and-drill in learning; other might suggest that educational games need to be built on constructivist or social constructivist theoretical frameworks [10]. When educational computer game is adopted as a learning tool in classrooms, teacher should either create or adapt the learning materials to maximize the game's potential to support learning. As such, the pedagogical value should definitely be taken into account when considering in adopting educational computer games for teaching and learning in a classroom. For example, computer game might be integrated into instructional design and should affect children's capabilities to perform certain cognitive functions [11]. From the study of Chuang and others [11], they found that cause-and-effect games tended to encourage means-end analysis strategy, whereas adventure games encouraged inferential and proactive thinking. Moreover, outcomes from several researches proved that significant correlation exists between game playing and children's problem solving skill and cognitive style [4], [12]. In order to make educational computer game "educational", Fisch [13] suggests that when designing game, the following matters should be included: 1) matching the education topic to the media, 2) placing educational content at the heart of the game play and 3) building feedback that supports learners into the handling of difficult content.

4 Learning Styles

Research into the use of games in education is growing rapidly [5], [7], [14], [15]. In order to understand the potential roles of mainstream games in supporting learning, we need first answer the questions "what is learning?" and "what forms of learning are suitable for incorporating games in the classroom?" This is related to pedagogical theory which includes learning theory which describing how people learn or what styles of learning people like. Learning style is useful in identifying the methods by which people prefer to receive information from their environment and undertake their

learning. Each person has his or her own way of converting, processing, storing, and retrieving information. Some people prefer to learn through reading and reflecting on how this might apply to their own experience, whilst others prefer to learn through trying ideas out and learn through reviewing their experience before planning the next step. Among the learning styles which classified as experiential, Honey and Mumford learning style is one of the well known experiential learning [16]. This learning style proves that people learn better when the teaching is adapted to the learning styles [2]. Honey and Mumford classify learners into activist, reflector, theorist, and pragmatist as illustrated in Table 1.

Table 1. Honey & Mumford learning style [16]

Characteristics			
Activists	**Reflectors**	**Theorists**	**Pragmatists**
• Immerse in new experience • Enjoy here and now • Open minded, enthusiastic, flexible • Seek to centre activity around themselves	• Stand back and observe. • Cautious, take a back seat • Collect and analyse data about experience and events, slow to react conclusion • Use information from experience to maintain a big picture perspective	• Think in a logical manner, rationally and objectively. • Assimilate facts into coherent theories. • Fit things into rational order. • Keen in basic assumptions, principles, theories, models and thinking system.	• Keen to put ideas, theories and techniques into practice. • Search new ideas and experimental • Act quickly and confidently on ideas, get straight to the point. • Are impatient with endless discussion

5 Game Genres, Learning Techniques and Learning Styles

Game genres can be categorised as Action, Adventure, Fighting, Puzzle, Role-Playing, Simulation, Sports, Strategy, etc. Different game genres have different impact on the content of learning activities [1]. Some contents are best learned through role-playing and adventure games, others are best through game show competition, action and even sport games [2]. Different games appeal to different people. Choosing the appropriate type depends on the content to be learned and /or mental processed to be developed. Prensky [1] proposes several variables to consider when selecting a game style including: target age level, gender, racial diversity, number of play, and the role of the teacher. Apart from these, pedagogy aspect especially learning style should be considered as one important variable. Knowing children's learning style and finding appropriate ways to create or enhance learning environment such as choosing appropriate game type for each style of learners will increase the student's learning success. Consequently, the questions follow are "what types of game should be created for each learning technique?" and "what types of game are appropriate for each learning style?"

This section presents the model of relationship between learning activities and game types based on the study of Prensky [1] in section 5.1; learning style and education game based on the study of Chong et al. [2] in section 5.2; This paper then proposes a

new conceptual model by comparing and matching learning styles, learning activities and game genres based on those two studies [1], [2] in section 5.3.

5.1 Prensky's Study: Learning Techniques and Learning Activities Used in Educational Computer Games

Games can be categorised in many different genres, including first-person shooters, role-playing, action, adventure, card, puzzle, and sports. If computer games are used in the classroom, the game genres should be selected to match the learning style. Different activities and learning techniques may use different types of game. Prensky [1] shows activities and learning techniques used in educational computer games are: 1) practice and feedback, 2) learning by doing, 3) learning from mistake, 4) goal-oriented learning, 5) discovery learning and guided discovery, 6) task-based learning, 7) question-led learning, 8) situated learning, 9) role playing, 10) constructivist learning, 11) multi-sensory learning, 12) leaning objects, 13) coaching, and, 14) intelligent tutors.

In his paper "Computer Games and Learning: Digital Game-Based Learning" [1], Prensky discusses about how to combine gameplay and learning. He claims that teacher have to understand the types of learning content. With different kinds of learning content, teacher can see what kinds of learning are really going on such as learning fact, skill, judgment, theory, reasoning, process, procedure, creativity, language, system, observation and communication. Additionally, teacher can choose different learning activities according to particular types of content. Prensky proposes the relationship of learning content, learning activities and possible game style as shown in Figure 1 and Table 2.

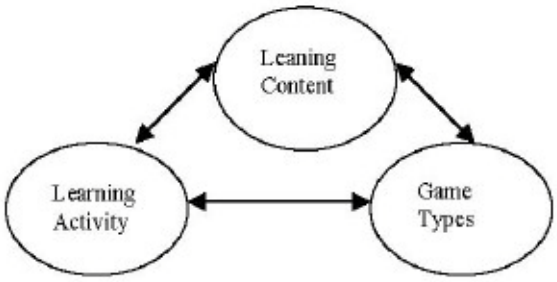

Fig. 1. Model of relationship of learning content, learning activities and possible game styles

5.2 The Study of Chong et al.: Learning Styles and Educational Game

Many educational researchers studied on learning styles, but the study on the relationship of learning styles to learning within game text is scarcely found. Researchers are emphasizing that the education computer games should be developed considering the learning styles of students [2]. However, there is a research conducted by Chong et al. on the impact of learning styles on the effectiveness of digital games in education. They conducted the survey based on the Honey and Mumford four types of learning styles on 50 undergraduate students in INTI College Malaysia. They choose three

Table 2. Finding Summary of Prensky's Learning Content, Leaning Activities and possible Game Styles [1]

Learning Content	Learning Activities	Possible Game Styles
Facts : laws, policies, product	Questions, memorization, drill, association	Game show competitions, flashcard types game, mnemonics
Skills: interviewing, teaching, management	Imitation, feedback, coaching, continuous practice	Persistent state games, role-play game, detective games
Judgment: management, decisions, timing, ethics	Reviewing cases, asking questions, feedback, coaching	Role-play games, multiplayer interaction, adventure game, strategy game, detective game
Behaviors: supervision, self- control, setting example	Imitation, feedback, coaching, practice	Role-play game
Theories: marketing rationales, how people learn	Logic, experimentation, questioning	Open ended simulation games, building game, construction games
Reasoning: strategic & tactical thinking, quality analysis	Problems, examples	Puzzles
Process: Auditing, strategy creation	System analysis & deconstruction, practice	Strategy games, adventure games
Procedure: assembly, bank teller, legal	Imitation, practice, play	Timed games, reflex games
Creativity: invention, product design	play	Puzzles, invention games
Language: acronyms, foreign language	Imitation, continuous practice, immersion	Role-play games, reflex games, flashcard games
Systems: health care, markets, refineries	Understanding principles, graduated tasks	Simulation games
Observation: moods, morale, inefficiencies, problems	Observing, feedback	Concentration games, adventure games
Communication: appropriate language, involvement	Imitation, practice	Role-play games, reflex games

different kinds of games namely: Counter Strikes, Championship Manager and Bookworm which are action role-playing game, strategy game and puzzle game respectively. The results show the student's preferences on the games vary related to learning styles. Chong et al. concluded that they need to conduct further studies on different types of learning styles as well as different game genres. The finding of Chong's study can be summarised in Table 3.

5.3 Bridging the Gap between the Prensky and Chong's Studies

When reviewing the studies of Prensky and Chong at al., we realized that more need to be done in order to provide a better framework for designing good educational games. Prensky focuses on learning techniques, learning contents, and learning activities but lack of learning style. Whereas, Chong et al. focus on learning style but uses only three

Table 3. Experimental finding summary based on Chong et al. [2]

	Role-playing games (Counter Strike)	Strategy games (Championship Manager)	Puzzles (Bookworm)
Activists	Enjoy playing this game	Discard the instructions given before the start of the game	Use their brainstorming to solve the problem
Reflectors	Prefer not to lead the game	Observed to follow the instructions given to them earlier	Not able to draw strong conclusion
Theories	Not able to draw strong conclusion	Reacted very similar to the reflectors	Did not learn and play well
Pragmatists	Dislike this game	Copied the strategy given during the briefing	Great interest in this game

different game genres as an example. Therefore, it is the attempt of this study to bridge this gap by establishing the linkage of these two studies. Two conceptual models proposed in this study are:

Firstly, as mentioned in section 5.1, Prensky proposes the relationship of learning content, learning activities and the game styles. He also suggested 14 essential learning techniques which he claimed that it should be considered and used when designing learning materials. However, these 14 learning techniques have not been matched to learning activities and game genres in his study. In order to use all those learning techniques in learning with educational computer game, the relationship of each learning techniques and game genres should be studied. Hence, it is the objective of this paper to compare and match his 14 learning techniques to learning activities and game genres. The new model and the result of this matching are illustrated in Figure 2 and Table 4.

Second, in section 5.2 Chong et al. [2] study the impact of learning styles on computer game in education. They use three types of games in their study as the examples to prove that different learning styles do prefer different types of games. From the finding of their study, the behaviors of each style of learners while playing game are also described. However, they do not match this behavior of each style of learners with learning technique. Additionally, only three different game styles are studies. While the study of Prensky choose all the standard categories of computer games matching with learning activities, but lacks of the comparison of learning style of the users. Thus, this paper proposes the new conceptual model of the relationship between learning styles, learning activities, and possible game genres based on these two studies [1], [2] as illustrated in Figure 3.

The process that led to the new model is conducted by: 1) exploring the behavior when playing games for each type of learner based on Chong's study, 2) matching the behavior of each type of learner to learning activities based on Prensky's study, and 3) finding the possible game genres which can relate to each learning activities. As an example, the results from this study found that the possible game genres for the activist learners could be multiplayer interaction, action games and role-playing game. Accordingly, the results of matching learning styles; behavior when playing game; behavior when using computer; learning activities; and possible game genres are shown in Table5.

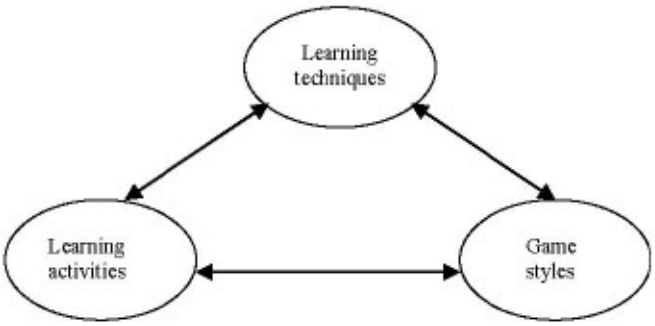

Fig. 2. Model of relationship of learning techniques, learning activities and possible game styles

Table 4. The relationship between learning techniques, learning activities and possible game styles

Learning techniques	Leaning activities	Possible game genres
Practice & feedback	Questions, memorization, association, drill, imitation	Game show competition, flashcard type game, mnemonics, action, sports game
Learning by doing	Interact, practice, drill, imitation	Strategy game, action game, role playing game
Learning from mistake	Feedback, problem	Role-play game, puzzle game
Discovery learning & guided discovery	Feedback, problem, creativity play	Adventure game, puzzle game
Task-based learning	Understand principle, graduated tasks	Simulation game, puzzle game
Question-led learning	Question/ questioning, problem	Quiz or trivia game, game show competition, construction game
Situated learning	Immersion	Immersive style game such as role-playing game, flashcard game
Role playing	Imitation, practice, coaching	Role-playing game, strategy game , reflex game, adventure game
Constructivist learning	Experimentation, questioning	Building game, constructing game
Multisensory learning	Imitation, continuous practice, immersion	Game in which introduce new technologies such as locatable sound or force feedback, reflex game
Learning object	Logic, questioning	Games which are becoming object-oriented
Coaching	Coaching, feedback, questioning	Strategy game, adventure game, reality testing game
Intelligent tutors	Feedback, problem, continuous practice	Strategy game, adventure game, puzzle game, reflex game

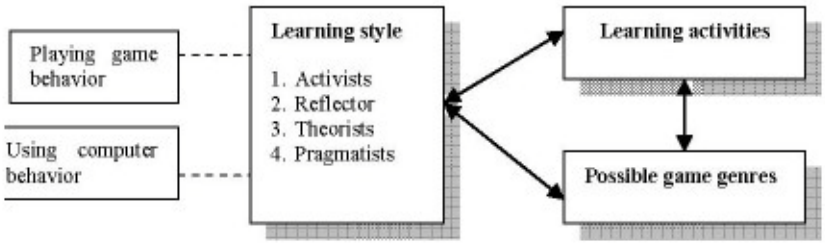

Fig. 3. Model of relationship of learning styles, learning activities and possible game genres

6 Discussion

As researchers have found that computer games have significant educational value, computer games can become part of the school curriculum. There are different types of computer games and games technologies, which have been used positively, both directly and indirectly to support and assist teaching and learning in the classroom. Green and McNeese [17] conclude in their paper "Using Edutainment Software to Enhance Online Learning" that the attributes of high quality educational computer games comprise of 1) clear learning goal and objective, 2) provide review on concepts newly learned and allow for questions and answers, 3) develop higher thinking skills, 4) challenging but focus on learning rather than on winning or losing, 5) clear rules so learners know how to play, 6) providing a means for collaboration, feedback, or guidance, 7) be fun so learners are more relax, more alert, less fearful and open to learning, 8) provide a means for debriefing to recap what was learned and allow for question and answer. However, there are a number of issues, which need to be addressed before using computer games in the classroom.

Most studies concern about age of student, gender, racial diversity, and role of the teacher. Unfortunately, not many researches focus on learning style when designing the appropriate game genres for each style of learners. Different people have different style of learning. No single learning preference is better than any other. In fact, individual student may have more than one single learning style. This reflection can be shown that when some learners prefer kinesthetic instruction, they can also have ability to learn orally and visual [18]. One learner has the active type of learning; he/she may have theory or pragmatic style of learning in other learning situation. Therefore, there are many possible ways in choosing appropriate game genres for one particular student. However, it can be determined by looking at learner's dominate learning style. In other word, the most preferred learning style of that learner. The model of relationship of learning style, learning activities and possible game genre presented in this paper is only the potential example proposal. To understand educational gaming, many factors have to be examined. These include design, pedagogy, and literacy. It should also focus on the classroom use, what is learned and what can be taught with educational computer game [13]. Moreover, some variables such as the experience in playing game, culture, language, and nurture should also have been examined. Game developers and educational psychologists should work together with other professionals as a team to formulate the educational content in order to build quality educational computer games.

Table 5. The relationship of learning style, behaviour when playing game, behaviour when using computer, learning activity and possible game genres [1]. [2], [16]

Leaning styles	Behaviour when playing game	Behaviour when using computer	Learning activities	Possible game genres
Activists	Prefer working as a team, being a group leader, Be able to brainstorm to solve the problem	Like to use shortcut key-combinations but will also find the toolbar buttons useful.	• Practice • Imitation • Work with other • Tackle problem 'head on'	Multiplayer interaction, action game, role-playing game
Reflectors	Go through the important data in	Prefer to use dropdown menus but	• Observing • Feedback	Concentration game,
	the game, follow the instructions, spend a long time before make decision, not to lead the game	will soon discover what is best for themselves, like to browse through SEARCH FOR HELP in the HELP menu	• Graduated task • Work alone at their own pace	adventure game, simulation game
Theorists	Go through the data and follow the instruction before start the game, be able to give careful thoughts when choosing the game elements, Formulate good strategy to defeat the enemy	Often use dropdown menus to see what else the application can do, like to browse through the INDEX or SEARCH FOR HELP in the HELP menu	• Logic • Understanding Principle • Analyse & develop plan • Explore relationship between things	Strategies game, simulation game
Pragmatists	Follow closely the instructions & strategies that were mentioned in the briefing, believe they can play better if they were given proper instruction, Show a great interest in puzzle game and dislike role-playing game	Probably use the toolbars buttons to get things done, often find HELP menu to get things done	• Experimentation • Asking question, • Try things out • structure plan with definable purpose	Puzzle game, building game, constructing game, reality testing game, detective game

The further questions are: How do educators convince parents, teachers, and administration about the importance of gaming in education? [13]; Are there any significant gains when determine the appropriate genre of game with learning styles? And are there any relationship between teaching styles and using of educational computer games?

7 Conclusions

Educational computer games bring together the idea of game, play, fun, hands-on experience and also with explicit educational purpose. Like other genres of computer games, educational computer games have elements that benefit learning. This includes rules, goals, active engagement, content/story, feedback, interactive, problem solving, quick adaptation and immediate reward. However, educational content in education computer games should be considered as the heart of game, and feedback that support learners should also be built into difficult content. When designing educational computer games for supporting learners in classroom, apart from educational content, they can also embrace the pedagogical benefits such as learning style with game genres for developing quality learning experience in class. This paper shows the comparison and matching of learning techniques, learning activities, learning styles to possible game genres. However, this study merely proposes the potential model used as one possible conceptual guideline for further study in order to create effective educational computer games. Further study may find out the benefit gain when determine the appropriate genres of game with learning styles.

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